

## Further Results on the Decay of $^{178}\text{Tl}$

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As reported last year, a 90% enriched 1.05 mg/cm<sup>2</sup> target of  $^{102}\text{Pd}$  was bombarded by a 340 MeV beam of  $^{78}\text{Kr}$  ions at the 88-Inch Cyclotron to produce  $^{178}\text{Tl}$  with a cross section  $\sim 40$  nb. This resulted in high yields of Hg isotopes, and also Au and Tl isotopes in lower yields. These reaction products were separated from the  $^{78}\text{Kr}$  beam in the Berkeley Gas-filled Separator (BGS), passed through two parallel-plate avalanche counters (PPAC's) and were implanted into a position-sensitive silicon strip detector. Chains of known alpha decays observed from the same position on the detector shortly after implantation ( $<20$  s) permitted the reaction products to be positively identified by comparing the energies of the alpha decays to values in the literature. By recording the time intervals between decays, half-lives were also deduced.

Data have been analyzed again to determine the half-lives of short-lived isotopes with the alpha decay rate function:

$$\frac{dN}{dt} = \lambda e^{-(\lambda + R_{\text{EVR}} + R_{\alpha})t}$$

and the correlation efficiency equation:

$$\varepsilon_{\text{corr}} = \left( \frac{\lambda}{\lambda + R_{\text{EVR}} + R_{\alpha}} \right) (1 - e^{-\lambda t_{\text{search}}})$$

where  $\lambda$  is the decay constant for the alpha decays of interest, and  $R_{\text{EVR}}$  and  $R_{\alpha}$  are the rates of random Evaporation Residues (EVR's) and random  $\alpha$  decays, respectively.  $t_{\text{search}}$  is the maximum correlation search time.

TABLE I. A summary of observed  $^{178}\text{Tl}$  alpha-decay transitions. The half-life determined from all four transitions combined is  $^{254}_{-9}^{+11}$  ms.

Energy (MeV)	Lit. Energy (MeV)	Q-Value (MeV)	Relative intensity	Half-life (ms)
6.616(15)	--	6.768(15)	0.23	$^{224}_{-19}^{+25}$
6.704(5)	6.71	6.858(5)	1	$^{247}_{-11}^{+14}$
6.785(5)	6.79	6.940(5)	0.30	$^{273}_{-20}^{+26}$
6.859(5)	6.87	7.017(5)	0.17	$^{246}_{-21}^{+29}$

Approximately 1200 alpha decays were observed correlated to 6.538 MeV  $^{174}\text{Au}$  alpha decays, or to the 6.038 MeV alpha particles of its beta-decay daughter,  $^{174}\text{Pt}$  [1]. Four transitions, assigned to  $^{178}\text{Tl}$ , are resolved, with energies of 6.616(15), 6.704(5), 6.785(5) and 6.859(5) MeV and relative intensities of 23%, 100%, 30% and 17%, respectively. The combined half-life of these transitions is  $^{254}_{-9}^{+11}$  ms (See table I). The half-life of each of the individual transitions agrees with the combined half-life, so it is presumed that these are decays from the ground state of  $^{178}\text{Tl}$  to different  $^{174}\text{Au}$  states, rather than from  $^{178}\text{Tl}$  isomers. If the 6.859 MeV decay proceeds to the  $^{174}\text{Au}$  ground state, the lower limit on the  $^{178}\text{Tl}$  mass excess is  $-4.61(15)$  MeV.

Additional information was deduced by examining the entire  $^{178}\text{Tl}$  decay chain. From the ratio of  $^{178}\text{Tl}$  decays correlated to  $^{174}\text{Au}$  vs.  $^{174}\text{Pt}$  decays, a  $^{174}\text{Au}$  alpha decay branch of 90(6)% was calculated. Gold-174 was found to be correlated with 5815 keV decays, but not to the previously reported decays of its daughter,  $^{170}\text{Ir}$  [1]. Based on the systematics of Ir isomers, the new transition is assigned to the ground state of  $^{170}\text{Ir}$ , which implies a mass excess of  $-23.48(15)$  MeV.

### Footnotes and References

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1. R. D. Page, *et al.*, Phys. Rev. C **53**, 660 (1996), and references cited therein.